Observational constraint on particle shapes in optically thin ice clouds using CALIOP–IIR measurements

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Current remote sensing of ice clouds using spaceborne observations assumes a single ice particle model, such as the severely roughened eight-column aggregate model for MODIS Collection 6 cloud products. In reality, however, in-situ measurements and laboratory experiments indicate that ice particles have preferred shapes depending on atmospheric states. In particular, atmospheric temperature plays an important role in ice particle shapes, as confirmed by several case studies. Recent efforts on remote sensing of ice clouds enable investigation of ice particle shapes based on polarimetric and/or combined satellite measurements. In particular, spaceborne active polarimetric measurements are sensitive to horizontally oriented plate crystals. Since plate particles in a certain size range could have horizontal orientations based on aerodynamics, the plate fraction could be estimated from spaceborne active polarimetric measurements.

This study uses ice cloud retrievals based on combined CALIOP–IIR measurements to investigate ice particle shape with a focus on plate crystals [1]. We implement updated bulk ice optical properties into the retrieval algorithm using a recently developed single-scattering property database of oriented ice crystals [2]. Based on the aforesaid retrievals, we construct a globally representative ice particle model that considers a mixture of plate and column-aggregate crystals. The results suggest that fractions of plate crystals increase with increasing atmospheric temperature up to –20 °C, which is consistent with previous in-situ measurements and laboratory experiments. In the presentation, we will demonstrate the bulk scattering properties of the proposed ice particle model for passive polarimetric observations.

References

[1] Saito M., H. Iwabuchi, P. Yang, G. Tang, M. D. King, and M. Sekiguchi, 2017: Ice particle morphology and microphysical properties of cirrus clouds inferred from combined CALIOP–IIR measurements. *J. Geophys. Res. Atmos.* **122,** 4440–4462.

[2] Saito M., and P. Yang, 2019: Oriented ice crystals: a single-scattering property database for applications to lidar and optical phenomenon simulations. *J. Atmos. Sci.*, in press.

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